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NAVAL POSTGRADUATE SCHOOL
Monterey, California

Basic Research in Thermoacoustic Heat Transport

by

Anthony A. Atchley

June 1996

Technical Report for Period 01 Jun 95 - 31 May 96

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This technical report details progress in basic research in thermoacoustic heat transport made during the period June 1, 1995 through May 30, 1996. Research efforts were primarily concentrated in three areas: 1) investigation of fundamental limitations to the performance of thermoacoustic devices; 2) design, construction, and demonstration of a proof-of-concept, shipboard, heat driven thermoacoustic cooler capable of cooling loads of 1 kW; 3) measurement of transient effects in thermoacoustic devices to provide data to test nonlinear, time-dependent models of thermoacoustics. Accomplishments include 1) the design of a prototype toroidal prime mover; 2) preliminary measurements of the temperature evolution along a stack in a mechanically driven configuration; 3) preliminary measurements of transient effects in prime movers; 4) preliminary design of a new prime mover configuration; and 5) fabrication of a 1 kW heat driven cooler. A publications, patents, presentations, and honors report is also included.

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ANNUAL SUMMARY REPORT

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BASIC RESEARCH

IN

THERMOACOUSTIC HEAT TRANSPORT

01 June 1995 - 31 May 1996

by

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ABSTRACT

This annual summary report details progress in basic research in thermoacoustic heat transport made during the period 01 June 1995 through 31 May 1996. Research efforts were primarily concentrated in three areas: 1) investigation of fundamental limitations to the performance of thermoacoustic devices; 2) design, construction, and demonstration of a proof-of-concept, shipboard, heat driven thermoacoustic cooler capable of cooling loads of 1 kW; 3) measurement of transient effects in thermoacoustic devices to provide data to test nonlinear, time-dependent models of thermoacoustics. Accomplishments include 1) the design of a prototype toroidal prime mover; 2) preliminary measurements of the temperature evolution along a stack in a mechanically driven configuration; 3) preliminary measurements of transient effects in prime movers; 4) preliminary design of a new prime mover configuration; and 5) fabrication of a 1 kW heat driven cooler. A publications, patents, presentations, and honors report is also included.

Project Description

The purpose of this project is three fold: 1) investigate fundamental limitations to the performance of thermoacoustic devices; 2) design, build, and demonstrate a proof-of-concept, shipboard, heat driven thermoacoustic cooler capable of cooling loads of 1 kW; 3) measure transient effects in thermoacoustic devices to provide data to test nonlinear, time-dependent models of thermoacoustics.

Approach

This project is, primarily, experimental-based. Specific areas of experimentation either continued or initiated during the reporting period include 1) investigation of a toroidal prime mover; 2) measurements of the temperature evolution along the stack in a mechanically driven configuration, 3) measurements of the evolution of the acoustic waveform and temperature distribution in heat exchangers in a prime mover from the off-state to steady-state, 4) investigation of new prime mover configurations designed to achieve greater amplitudes, 5) fabrication of a 1 kW heat driven cooler. NPS thermoacoustics work tends to focus on using prime movers because they can generate much greater acoustic pressure amplitudes than can conventional electromechanically driven acoustic resonators. Therefore, the nonlinear regime is more easily reached. A significant amount of the effort is a collaborative among Professors Atchley, Hofler and Keolian.

Accomplishments

Specific accomplishments in the five areas cited above are listed below. 1) The design of a prototype toroidal prime mover is complete. Fabrication is 80% complete. Analysis techniques are under further development. Current focus is on treating the toroidal prime mover as an infinite periodic lattice. 2) A new experimental apparatus has been constructed to measure the temperature evolution along a stack in a mechanically driven configuration. Results of preliminary measurements were presented at the Indianapolis meeting of the

Acoustical Society of America. 3) A new experimental apparatus has been built to measure transient effects in prime movers. Results of preliminary measurements were also presented at the Indianapolis meeting of the Acoustical Society of America. 4) Analysis of past and current NPS research involving heat exchanger performance and various stack geometries has led to preliminary designs for a new prime mover configuration. Construction of this prime mover is planned for the future. 5) Fabrication of the first phase of the 1 kW cooler is 90% completed. Testing of the prime mover portion should be underway by the end of the fiscal year. Testing of the cooler should begin early in the next fiscal year.

OFFICE OF NAVAL RESEARCH
PUBLICATION/PATENTS/PRESENTATIONS/HONORS REPORT
for
01 June 95 through 31 May 96

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a. Number of papers submitted to refereed journals but not yet published: 1

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g. Number of patents granted: 0

h. Number of invited presentations at workshops or professional society meetings: 1

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Graduate student FEMALE:	0	Post doc FEMALE:	0
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P3H Report Continued
01 June 95 through 31 May 96

Honors/Awards,/Prizes, etc.

Promoted to Professor of Physics, Naval Postgraduate School

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